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Biogeographical patterns in pyrenomycetous fungi and their taxonomy. 1. The Grayan disjunction

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Abstract — In this paper the biogeographical pattern known as the Grayan disjunction is discussed with respect to pyrenomycetous fungi. The importance of considering biogeographical data in taxonomy is emphasized. *Apiognomonia duschekiae* is described as a new species, *Biscogniauxia alnophila* is proposed as a new name for *B. mediterranea* var. *microspora,* and *Nemania sphaeriostoma* is proposed as a new combination.

Key words — *Ascomycota*, biogeography, distribution

Introduction

The importance of pyrenomycetous fungi in ecosystems as decomposer organisms cannot be overestimated, but many issues relating to their taxonomy, ecological preferences, and geographical patterns remain unclear on a global scale.

Many pyrenomycetous fungi are restricted to particular hosts, and this association suggests that each species follows the distribution of its substrates, at least within uniform climatic zones, such as the cold temperate, warm temperate, or tropical zones. Indeed, there are circumpolar, circum-boreal, and pan-tropical pyrenomycete species, which some might consider to represent the primary distribution patterns for these fungi. More limited and peculiar patterns have been not discussed or even suspected. As a result, although the Asian mycobiotas are not similar to the European mycobiota, mycologists often have applied European names to morphologically similar Asian fungi because they assume that fungi are widely distributed.

This paper discusses one biogeographical pattern that is usually termed the Grayan (Petersen & Hughes 2007) or Graysian (Tulloss 2005) disjunction in mycological literature. A number of plants and animals restricted to eastern North America where remnants of the ancient Tertiary flora persist can also occur in similar fragments of that flora in eastern Asia. Such a distribution, known as the famous "Asa Gray disjunction," has been reported for species of fungi, primarily macrofungi (Hongo & Yokoyama 1978, Zang 1986, Wu & Mueller 1997, Yang 2000, Mueller et al. 2001) or lichenized fungi (Culberson 1972, Dey 1976, Wei & Biazrov 1991). An examination of the biogeographical patterns of pyrenomycetous fungi, which have not been considered previously, reveals a number of examples of Grayan distribution.

Materials and methods

The specimens mentioned in this study were collected by the senior author over many years throughout eastern Russia and the eastern United States. The basic map was taken from the web site http://commons.wikimedia.org and modified with our data. Photographs of ascomata were obtained using a Nikon D40x digital camera.

Non-vicariance pattern

Among the pyrenomycetous fungi are two species groups that demonstrate a Grayan distribution—those that occur in eastern Asia and eastern North America and those that display a vicariance pattern. Examples of the first group are *Fracchiaea callista* (Berk. & M.A. Curtis) Sacc. (Fig. 1), "*Diatrypella informis*" Ellis & Everh. (Fig. 2), *Graphostroma platystoma* (Schwein.) Piroz. (Fig. 3), and possibly *Nitschkia floridana* Fitzp. (Vasilyeva et al. 2010). *Graphostroma platystoma* occurs on dead branches of many kinds of trees, suggesting a wide distribution, but the fungus displays an affinity for eastern Asia and eastern North America. Similarly *Diatrype albopruinosa* (Schwein.) Cooke is found only in these two widely separated areas (Fig. 4); it has a broad tree host range in eastern North America (Rappaz 1987) but occurs only on *Padus avium* Mill. in eastern Russia. This is not the only example of an apparent substrate preference displayed by pyrenomycetous or loculoascomycetous fungi in eastern Russia.

As another example, *Byssosphaeria rhodomphala* (Berk.) Cooke, occurs in eastern Russia only on *Maackia amurensis* Rupr., *Phellodendron amurense* Rupr., and *P. sachalinense* (F. Schmidt) Sarg., whereas in North America this species is known mostly on *Populus* spp. and *Robinia pseudoacacia* L. (Barr 1990). Both *Populus* and *Robinia* are present in eastern Russia, yet they apparently never serve as hosts to *Byssosphaeria rhodomphala*. *Maackia* and *Robinia* are both members of the *Fabaceae,* unlike the more distantly related *Phellodendron* (*Rutaceae*) and *Populus* (*Salicaceae*). The preference of the same

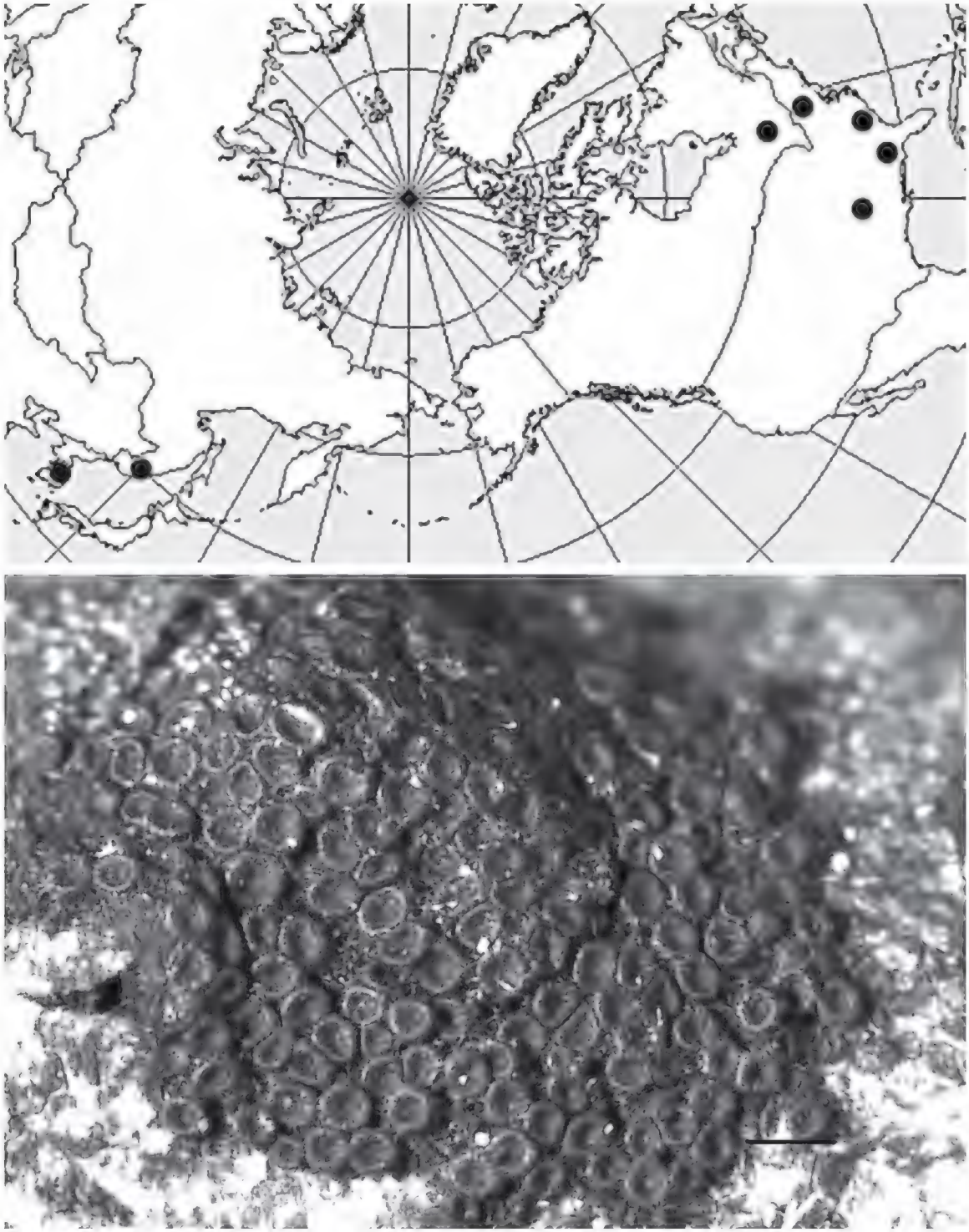

FIG. 1. Approximate biogeographical distribution of *Fracchiaea callista*. For North America, Nannfeldt (1975) cited the Alabama, Ontario, Pennsylvania, and South Carolina localities while the westernmost record thus far from Arkansas is supported by Vasilyeva's collection in the Buffalo National River; Connecticut, Maryland and Virginia are omitted. Localities in eastern Russia and South Korea are also based on the first author's own collections. Scale bar = 0.75 mm.

species for different hosts in different regions remains inexplicable — unless they are not the same species. If further studies prove them to be different species, they would represent a vicariance pattern in the Grayan distribution, discussed below.

A good example of Grayan disjunction is *Hypoxylon sphaeriostomum*, known earlier from the USA (Georgia, Ohio, and Pennsylvania; Miller 1961)

FIG. 2. Approximate biogeographical distribution of "*Diatrypella informis*". Only two localities are indicated for eastern Russia, although this species is rather common on dead branches of *Carpinus cordata* Blume and is also found throughout the Primorsky Territory, including the Sikhote-Ainsky Nature Reserve, Kedrovaya Pad Biosphere Reserve, Ussuriysky Nature Reserve, the Vladivostok vicinity, and near Anisimovka (District Shkotovo). The eastern North American locality is based on Ellis & Everhart's North American Fungi No. 2530 ("*Diatrypella informis* E. & E. n. sp. (TYPE), on dead *Carpinus*, London, Canada, Apr. 1890, J. Dearness"). Scale bar = 1 mm.

and recorded later from eastern Russia (FIG. 5). This species, which Ju & Rogers (1996) excluded from *Hypoxylon* (considering it to belong to *Euepixylon*), is treated herein as *Nemania sphaeriostoma*.

Some species that display an apparent Grayan distribution have been reduced to synonyms, although they are morphologically distinctive and have a restricted distribution. For instance, Ju et al. (1998) regarded *Biscogniauxia pezizoides* (Ellis & Everh.) Kuntze as synonymous with *B. repanda* (Fr.) Kuntze.

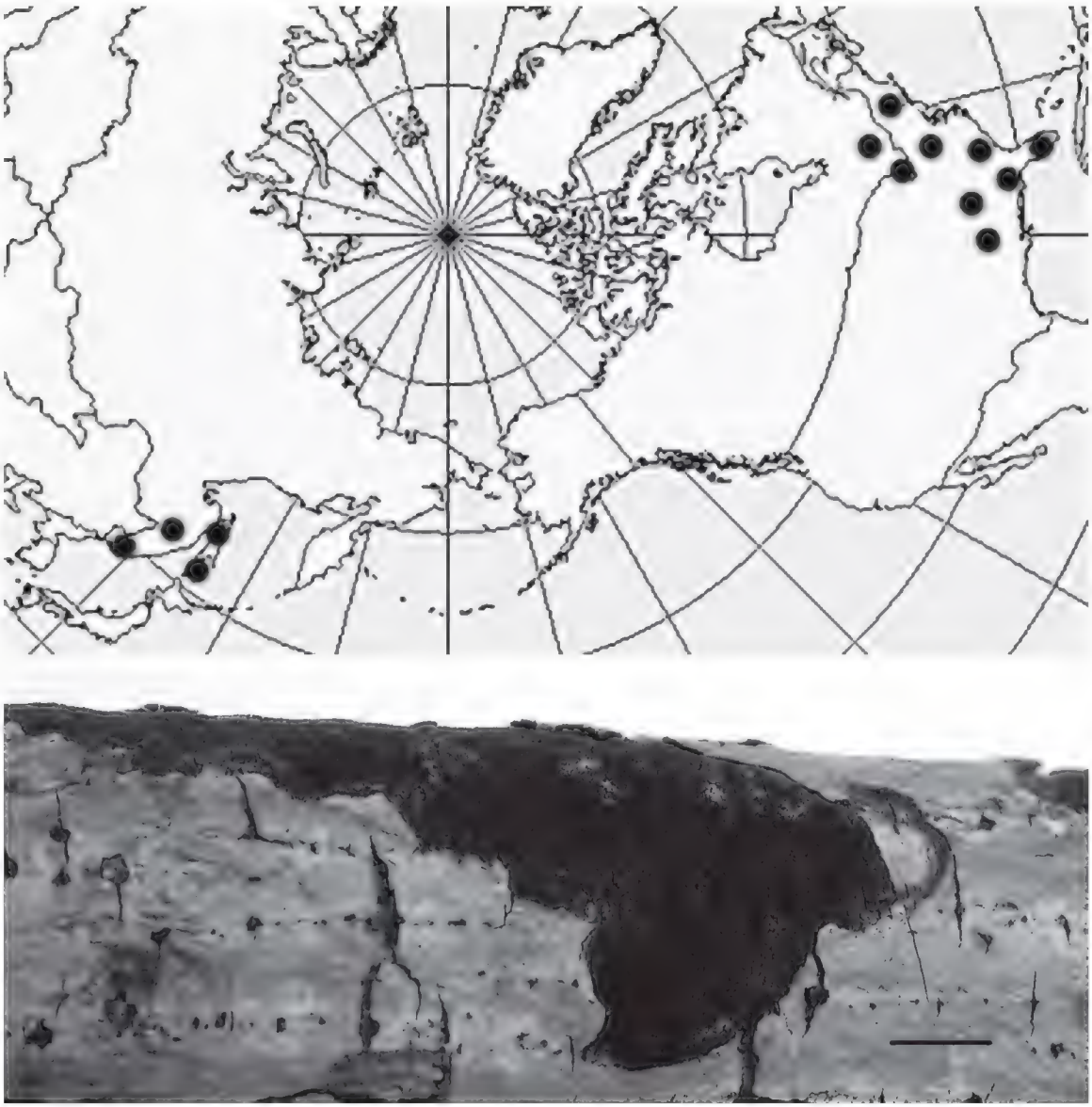

FIG. 3. Approximate biogeographical distribution of *Graphostroma platystoma*. North American localities listed by Pirozynski (1974) include Ontario and Quebec in Canada and Alabama, Arkansas, Florida, Massachusetts, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, and Vermont in the USA. The eastern Russian specimens were collected in the Primorsky and Khabarovsk territories, the Amur Region, and on Sakhalin and Kunashir islands. Scale bar = 0.7 mm.

However these two names might just as easily represent different species that are restricted to different host plants (mostly *Ulmus* and *Sorbus*, respectively) and their occurrence on different continents has already been noted (Pouzar 1979). The later discovery of *B. pezizoides* in eastern Asia (Vasilyeva 1998) fits its distribution in the Grayan disjunction (FIG. 6). Another example is *Diaporthella platasca* (Peck) Wehm. (FIG. 7), first described from the Adirondack Mountains in eastern United States (Peck 1873) and later been shown (Wehmeyer 1933) to have smaller stromata and larger ascospores (16–23 μm long) than the European species *D. aristata* (Fr.) Petr. (ascospores 13–16 μm long). However, the two species were later confused and referred to *D. aristata* (Barr 1978, Chlebicki 2002). When *D. aristata* and *D. platasca* were found in eastern

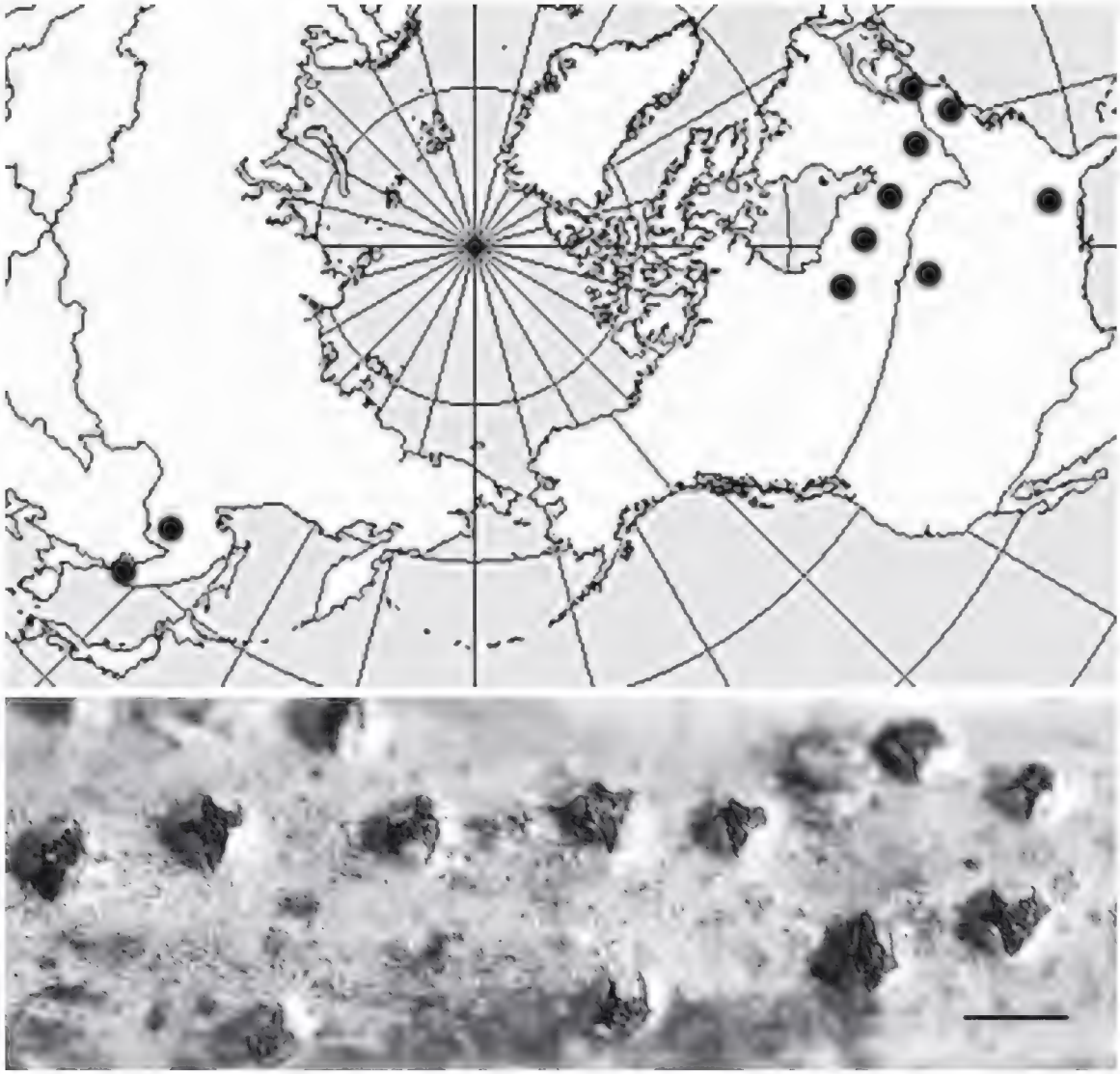

FIG. 4. Approximate biogeographical distribution of *Diatrype albopruinosa*. Some USA localities (Connecticut, the Dakotas, New Jersey, Mississippi) are from Rappaz (1987), and those for Canada (Manitoba, Ontario, Quebec, Saskatchewan) are taken from MycoBank (www.mycobank.com). The distribution range of this species in North America extends more to the west than for many other species with a Grayan disjunction. Only two collections are known from eastern Russia (in the Primorsky Territory and the Amur Region), but the senior author also found *D. albopruinosa* in China (Heilongjiang Province). Scale bar = 1 mm.

Asia—on the Kamchatka Peninsula and Sakhalin Island, respectively—their differences became evident, not only with respect to morphology but also in their ecological preferences. *Diaporthella aristata* parasitizes living branches of birch trees (*Betula ermanii* Cham.), whereas *D. platasca* occurs on dead branches of low shrubs (*Betula middendorffii* Trautv. & C.A. Mey.).

While describing the genus *Diaporthella*, Petrak (1924) noted the parasitic nature of *D. aristata*. However, the particular kind of substrate (trees or shrubs, in this case) might be of no importance, since Chlebicki (2002) indicated that *D. aristata* (with typical ascospores 14–16 µm long) occurs on living and dead twigs of a very low shrub (*Betula nana* L.). When discussing the material of *D. aristata* examined from North America, Barr (1978) made reference only to

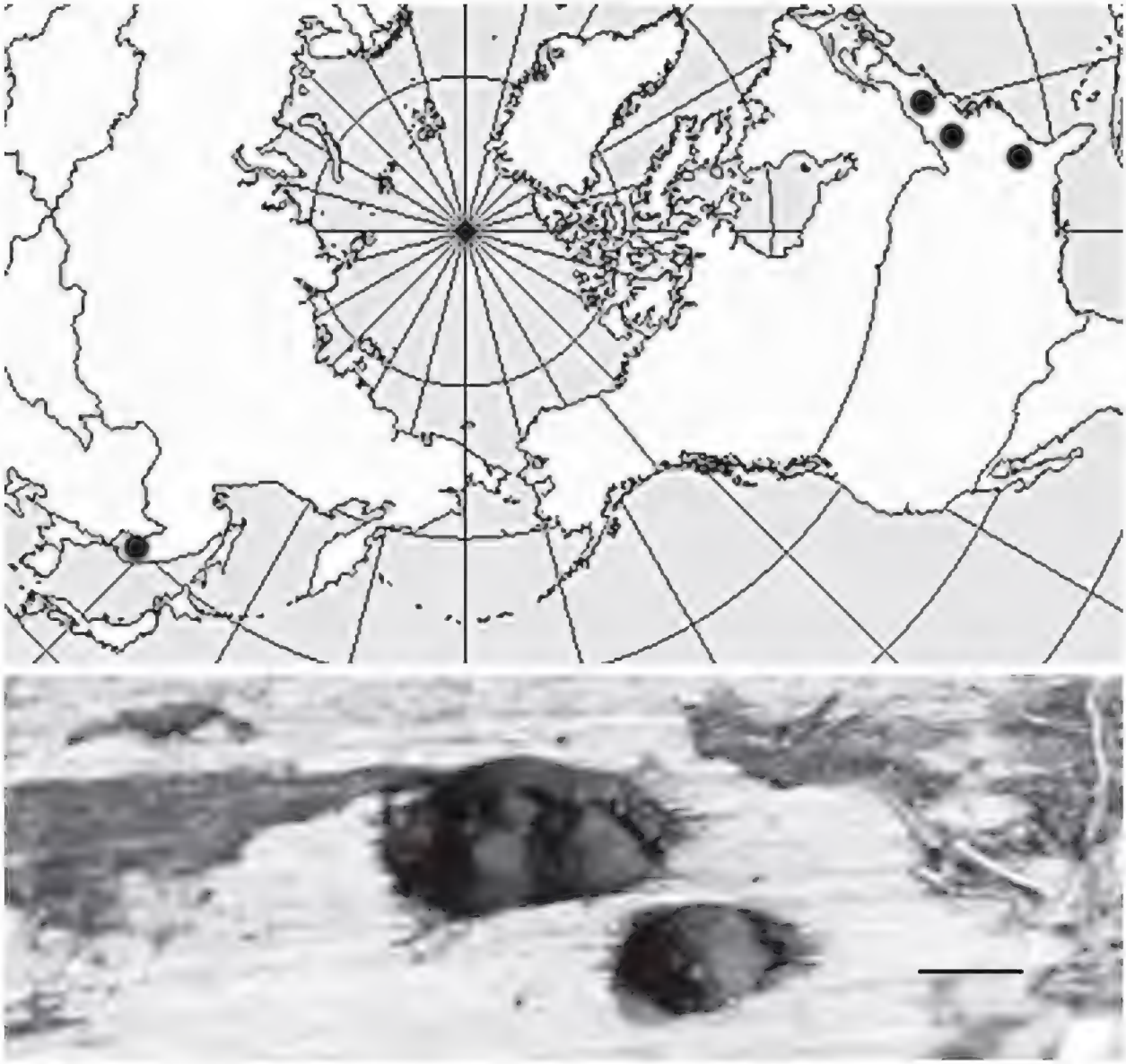

FIG. 5. Approximate biogeographical distribution of *Nemania sphaeriostoma*. The USA localities are cited by Miller (1961). The circle on the map encompasses the two collections from the Ussuriysky and Lazovsky Nature Reserves (Primorsky Territory) in eastern Russia. Scale bar = 1.5 mm

the type of *D. platasca*; therefore, the occurrence of the true *D. aristata* in North America is unknown.

The focus upon the biogeographical pattern discussed here has forced a reconsideration of species concepts. For example, specimens of *Apiognomonia alniella* (P. Karst.) Höhn. on the dead leaves of *Alnus fruticosa* Rupr. from the Magadan region (Vasilyeva 1987) fit Barr's description of a species indicated as occurring on overwintered leaves of *Alnus* spp. in Europe and North America (Barr 1978). However, Barr's North American specimens were collected in Quebec and Maine, regions in the eastern portion of the continent that share so many species in common with eastern Russia.

Further investigations showed that most of the European specimens of *Apiognomonia alniella* in exsiccatae contain living leaves of *Alnus incana* (L.) Moench covered by extensive necrotic spots caused by a parasitic fungus,

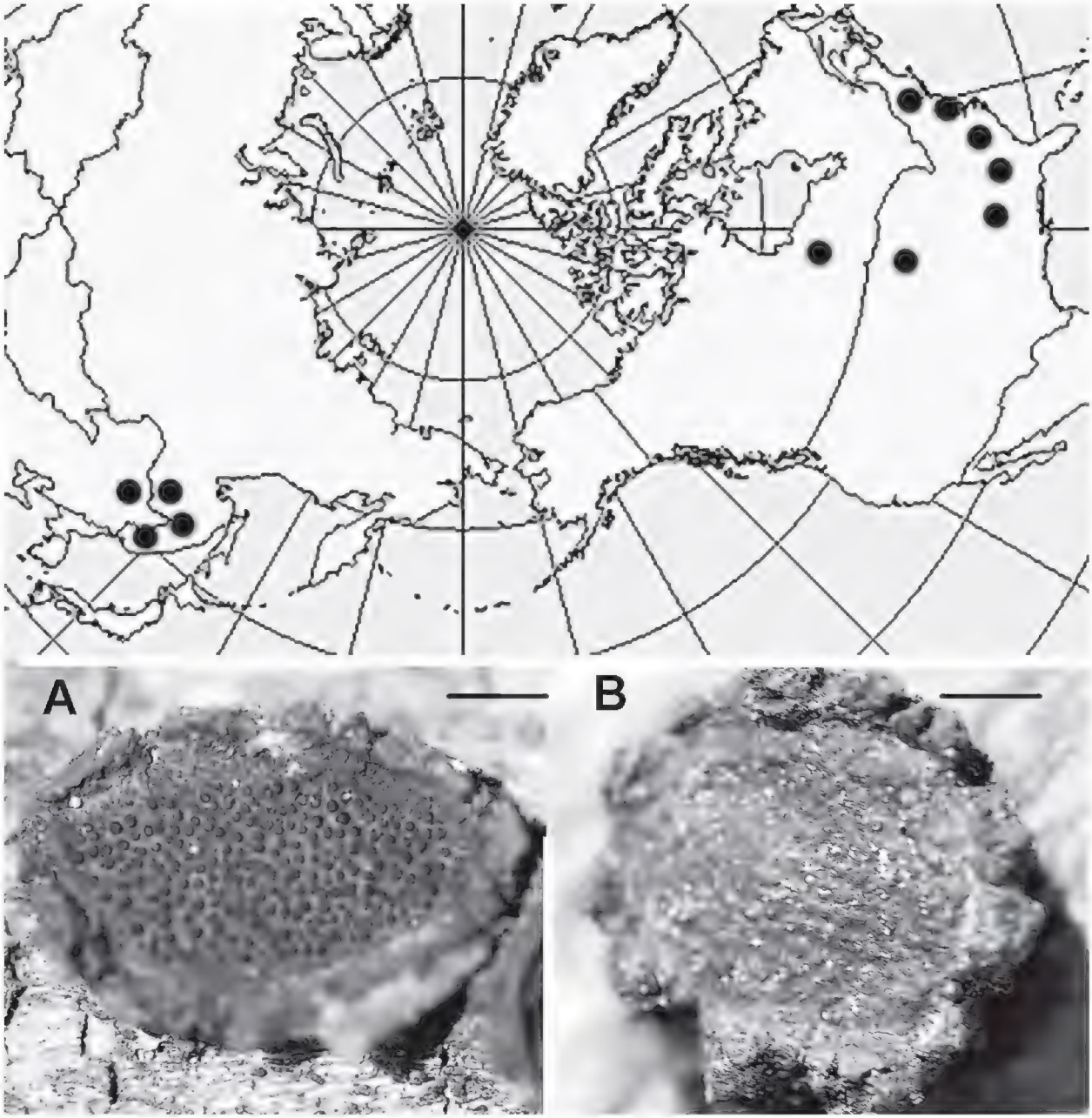

Fig. 6. Approximate biogeographical distribution of *Biscogniauxia pezizoides*. A - Stroma of *B. pezizoides* studded with the characteristic ostioles. B - Stroma of *B. repanda* [from western Russia, Leningrad Region, on *Sorbus aucuparia* L., D. Shabunin, VLA P-1429]. In North America, most localities (Delaware, Manitoba, Maryland, Nebraska, Virginia) are based on *B. pezizoides* specimens on *Ulmus* spp. (BPI collections: 595296, 595313, 595312, 595310, 595309); BPI 595300 from New York was collected on *Acer* sp., and the senior author has collected from *Acer* ap. in Tennessee (Great Smoky Mountains National Park) and from *Ulmus* sp. in Arkansas (Buffalo National River) as well as from *Acer mono* Maxim. and *Ulmus* spp. in eastern Russia and northeastern China (Heilongjiang province). Scale bars: 6A = 1.4 mm, 6B = 1.7 mm.

and the perithecia present are usually immature. We have observed exactly the same kind of a necrosis on living leaves of *A. hirsuta* (Spach) Turcz. ex Rupr. collected on the Kamchatka Peninsula. The immature perithecia were quite different from those on dead leaves of *A. fruticosa* in the Magadan region (Fig. 8). The immature state of the Kamchatka specimen did not allow us to make the proper comparison for a long time, but all the data available in the

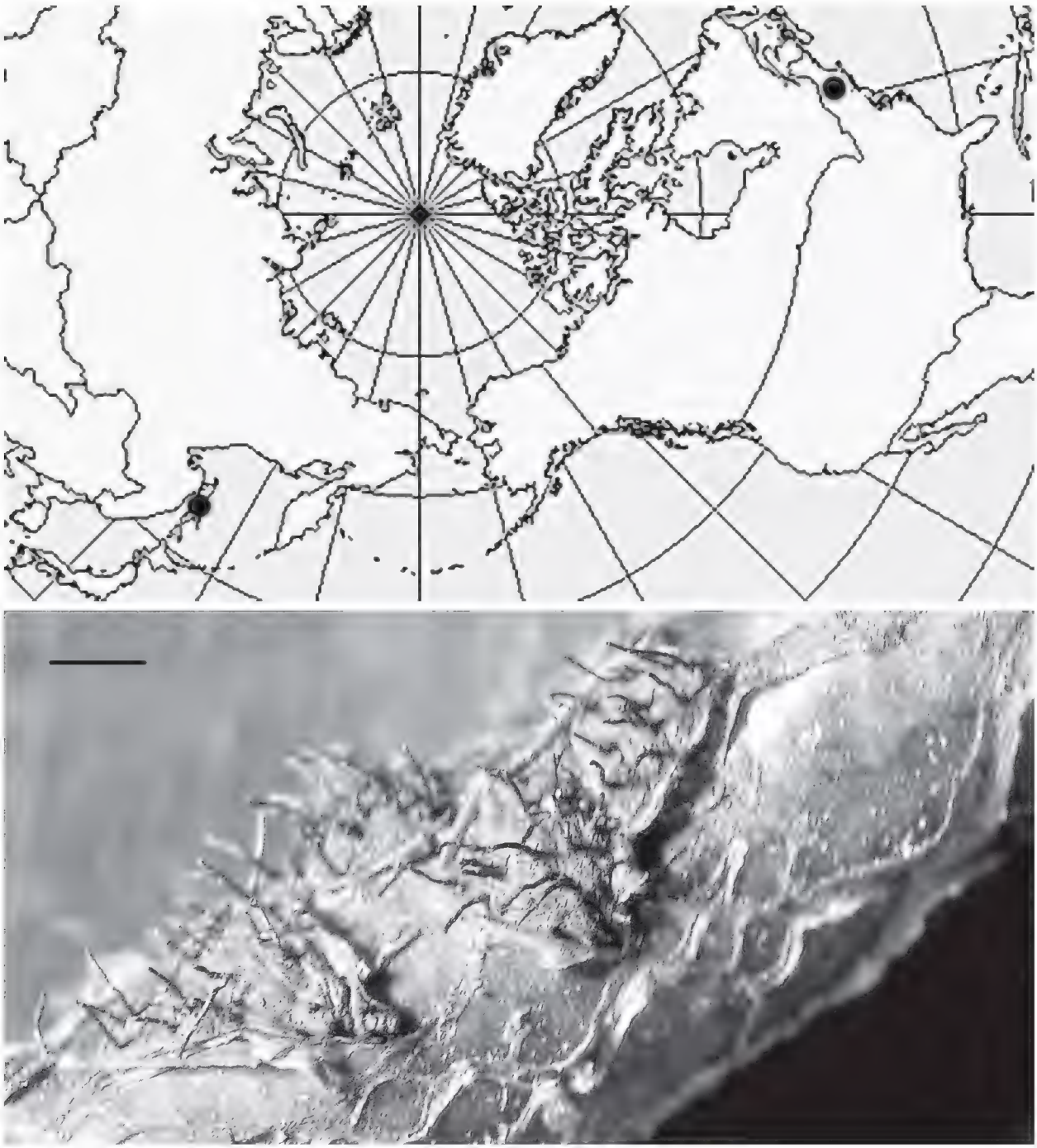

FIG. 7. Known localities for *Diaporthella platasca*. Scale bar = 1.25 mm

literature (Karsten 1873, Klebahn 1918, Monod 1983) indicate ascospores 8–10 µm long for *Apiognomonia alniella*, shorter than Barr's dimensions (10–16 µm) for her eastern North American material. This suggests that another species occurs in North America that might also be found in eastern Russia at the same latitudes.

We examined one specimen listed by Barr (Quebec: Manitou Gorge, 12 June 1955, R.T. Wilce) that appears exactly the same as specimens from Magadan region, with similar perithecia on dead leaves and same sized ascospores. Even the host leaves looked like those of *Alnus fruticosa*, sometimes referred to *Duschekia* and which supports an array of host-specific pyrenomycetes not

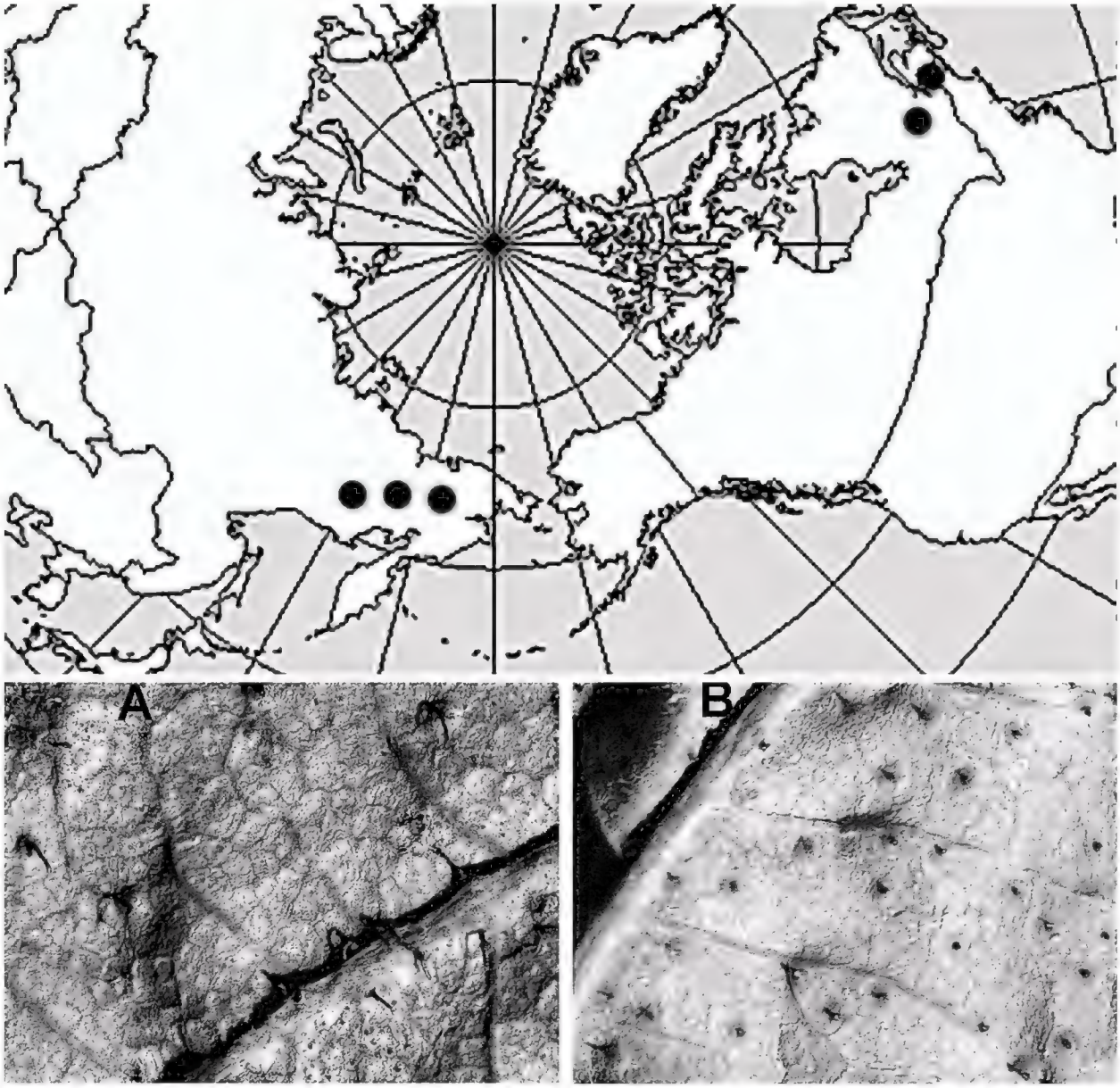

Fig. 8. Approximate biogeographical distribution of *Apiognomonia duschekiae*. The North American are from Barr (1978). In northeastern Russia, this species is rather common and found in many localities within the Magadan Region (vicinities of Kulu and Susuman; the Bol'shoy Anuy, Ilirneyveem, Kegali, Machvavaam, and Yasachnaya river basins; Lake Nizhny Ilirney) The same species should occur on dead leaves of *Duschekia fruticosa* in Yakutia (Shkarupa 1980), although we could not locate the specimen. A - elongated perithecial necks of *A. duschekiae* erumpent from leaf tissue. B - perithecial necks of *A. alniella* (from a specimen collected on *Alnus hirsuta* on the Kamchatka Peninsula).

found on true *Alnus* spp. (a kind of a substrate vicariance). For this reason, we describe below a new species of *Apiognomonia* (*A. duschekiae*), which seems to have a Grayan distribution (Fig. 8).

A similar situation can be observed in a specimen from the Magadan region identified as *Pleuroceras pleurostylum* (Auersw.) M.E. Barr following Barr's concept (Barr 1978, Vasilyeva 1987). Ascospores in the specimen averaged 50–70 µm long, corresponding with Barr's measurements of (35–)40–63 (–72) µm long. However, Monod (1983) described *P. pleurostylum* occurring

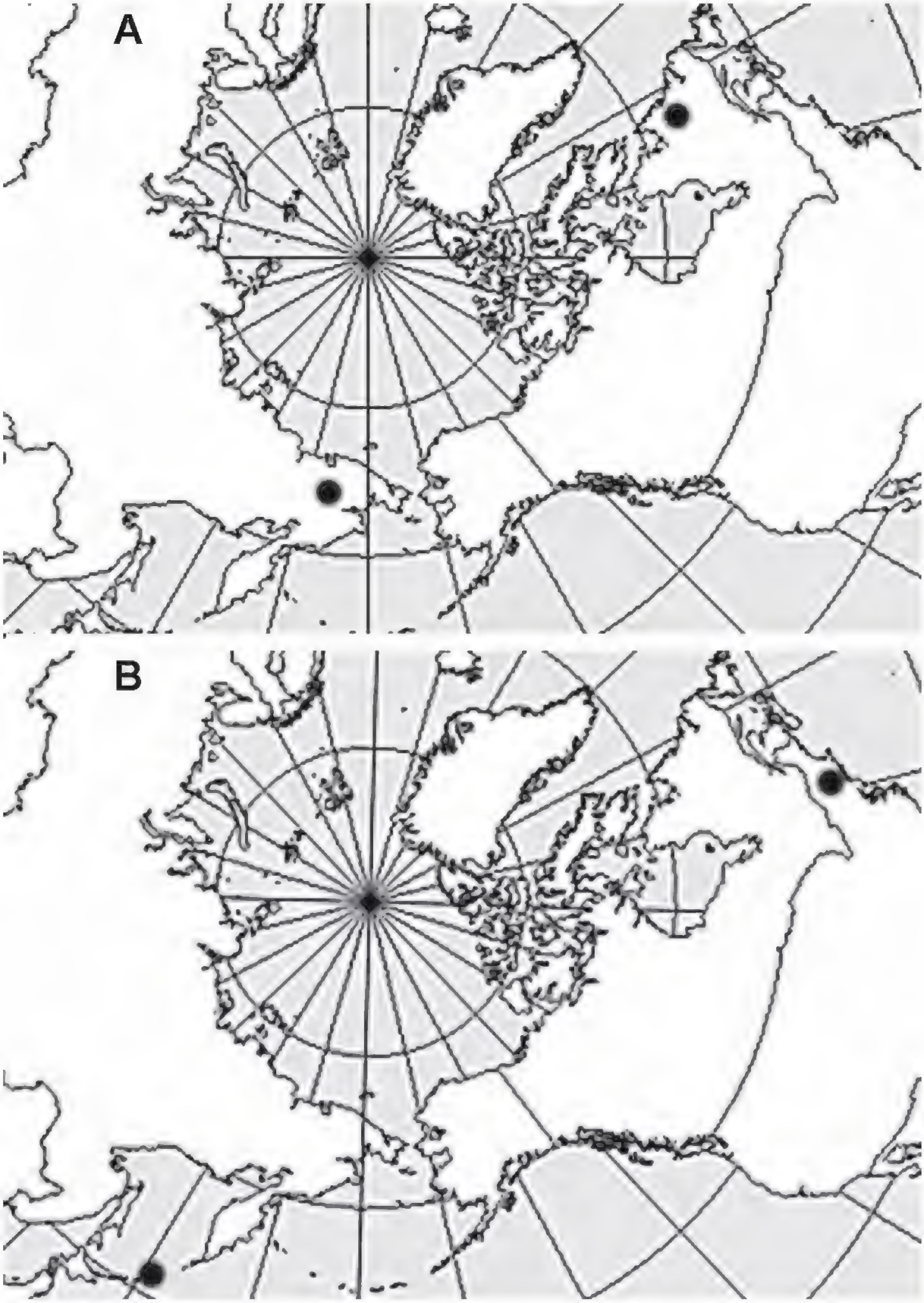

Fig. 9. Approximate biogeographical distributions:
A - *Pleuroceras labradorense*, B - *Gnomonia mirabilis*

in Europe as having ascospores 33–45 μm long, whereas the specimen from Labrador cited by Barr with longer (55–67 μm) ascospores served as the type for his new species *Pleuroceras labradorense* M. Monod. The collection from

the Magadan region better fits the description of *P. labradorense,* which appears to have disjunctive distribution in northeastern Asia and northeastern North America (Fig. 9A).

The same situation appears to be the case for *Gnomonia mirabilis* (Peck) M. Monod (Fig. 9B), which occurs on dead leaves of *Betula* spp. This fungus known from North America (New York: Barr 1978) was later found in eastern Asia (Kunashir Island: Vasilyeva 1998). Barr (1978) considered this taxon only a variety of *Plagiostoma campylostyla* (Auersw.) M.E. Barr, but *Gnomonia mirabilis* has appreciably longer ascospores (27.5–37.5 µm versus 18–27 µm in *P. campylostyla*). As this 'varietal' difference is surely larger than the difference Barr cited in her key to differentiate *Gnomonia fasciculata* Fuckel from *G. rhoicola* M.E. Barr (ascospores 11–15 and 13–16.5 µm long, respectively), it would seem appropriate also to distinguish *G. mirabilis* and *G. campylostyla* Auersw. at the species level. Monod (1983) listed three additional localities (Michigan, Ontario, Quebec) in eastern North America for *G. mirabilis*. The fungus probably occurs there, but Monod's species description cites an ascospore length of 21–32 µm, which would not distinguish it from *G. campylostyla*. Monod does not compare *G. mirabilis* with any other species of that genus in his key.

It is particularly noteworthy how often diaporthalean fungi display a Grayan disjunction. Recently, *Melanconis carpinigera* (Ellis & M.A. Curtis) Petr. was reported from eastern Russia (the Vladivostok vicinity), a species known previously from eastern North America (Wehmeyer 1941, as *M. chrysostroma* var. *ellisii* (Rehm) Wehm.) (Fig. 10) and the third species recorded from *Carpinus cordata* (along with *Fracchiaea callista* and "*Diatrypella informis*", discussed above) with such a distribution.

Testing for a Grayan distribution pattern may be useful for species already known from eastern North America when the same species is found in eastern Asia, particularly a taxonomic change might be indicated. For example, *Hypoxylon lividipigmentum* F. San Martín et al. was described from Mexico as having a teleomorph that is almost identical to *H. lividicolor* Y.M. Ju & J.D. Rogers known from Taiwan, except for the fact that the stromata of the former are thinner. Two species collected at almost the same latitudes (near the Northern tropics) in eastern North America and eastern Asia certainly warrant careful comparison. The senior author found a similar fungus in Texas (within the Big Thicket National Preserve), and there were reasons to identify it as *Hypoxylon lividipigmentum,* described from neighboring Mexico (the state of Quintana Roo), since southern Texas appears to share numerous species of pyrenomycetous fungi with Mexico. However, the stromata in the Texan specimen were rather thick, and J.D. Rogers (pers. comm.) was inclined to consider it to represent the Taiwanese *H. lividicolor*. The most probable conclusion is that the Taiwanese, Mexican, and Texan specimens belong to the same species being variable

FIG. 10. Approximate biogeographical distribution of *Melanconis carpinigera*. North American localities as cited by Wehmeyer (1941: Michigan, New York, Pennsylvania, Ontario) as collected by the senior author (Maryland— BPI 843491; Tennessee—878343). Scale bar = 1.4 mm

in stromatal thickness, and this species displays a familiar disjunction in its distribution. *Hypoxylon lividipigmentum* and *H. lividicolo*r are currently treated as separate species, since one of them has a *Nodulisporium*-like conidiogenous structure, whereas the other has a condiogenous structure that is *Sporothrix*-like (Ju & Rogers 1996). However, both *Nodulisporium*- and *Sporothrix*-like have been reported to occur within the same species (e.g., *Hypoxylon macrosporum* P. Karst.). Otherwise, *Hypoxylon lividipigmentum* and *H. lividicolor* represent a vicariance pattern in Grayan distribution (FIG. 11), and the specimen from Texas belongs to *H. lividipigmentum* despite its rather thick stromata.

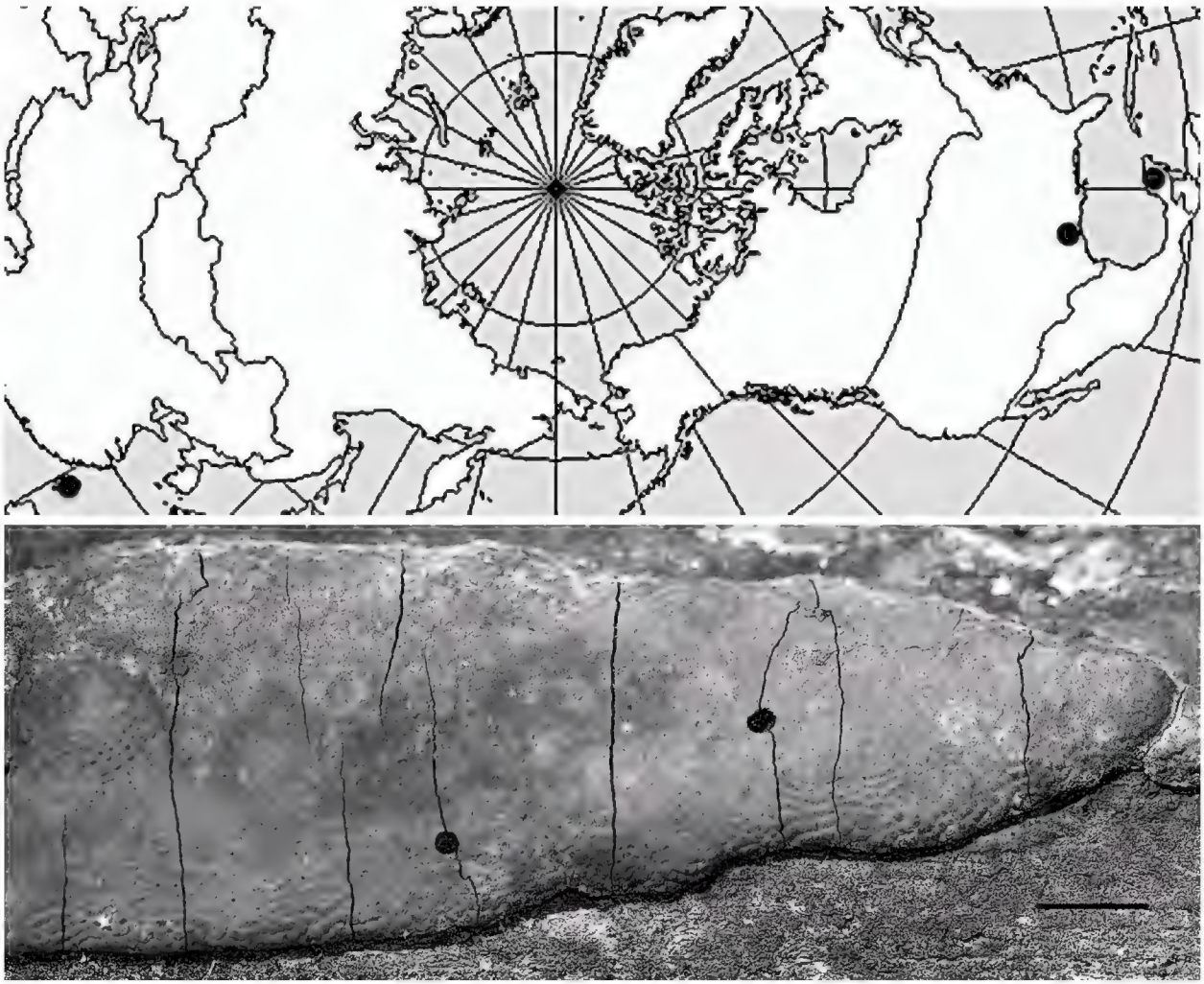

FIG. 11. Approximate biogeographical distribution of *Hypoxylon lividicolor* (Taiwan) and *H. lividipigmentum* (Mexico, Texas). Stroma: VLA P-2450 (Texas). Scale bar = 0.6 mm

Vicariance pattern

The vicariance pattern in Grayan distribution observed for some pyrenomycetous fungi is an even more interesting topic for discussion, since several species were described from eastern Russia as counterparts of eastern North American relatives, but only as varieties or synonyms of the latter. This additionally emphasizes an important taxonomic problem associated with estimating of differences in rank, which could be resolved by considering vicariant species pairs in eastern Asia and eastern North America.

One noteworthy example is *Biscogniauxia maritima* Lar.N. Vassiljeva, described as an east-Asian counterpart of the North American *B. atropunctata* (Schwein.) Pouzar (FIG. 12). In their disjunct regions, both species are restricted to *Quercus* spp. but differ considerably in ascospore size (13.2–16 × 6.6–8 µm versus 24–33 × 11–16 µm). Although *B. maritima* was later reduced to a variety of *B. atropunctata* (Ju et al. 1998), the vicariance pattern remains.

Nevertheless, the status of a taxon as a species or a variety is of importance, and the rank is determined after a careful consideration of differences that

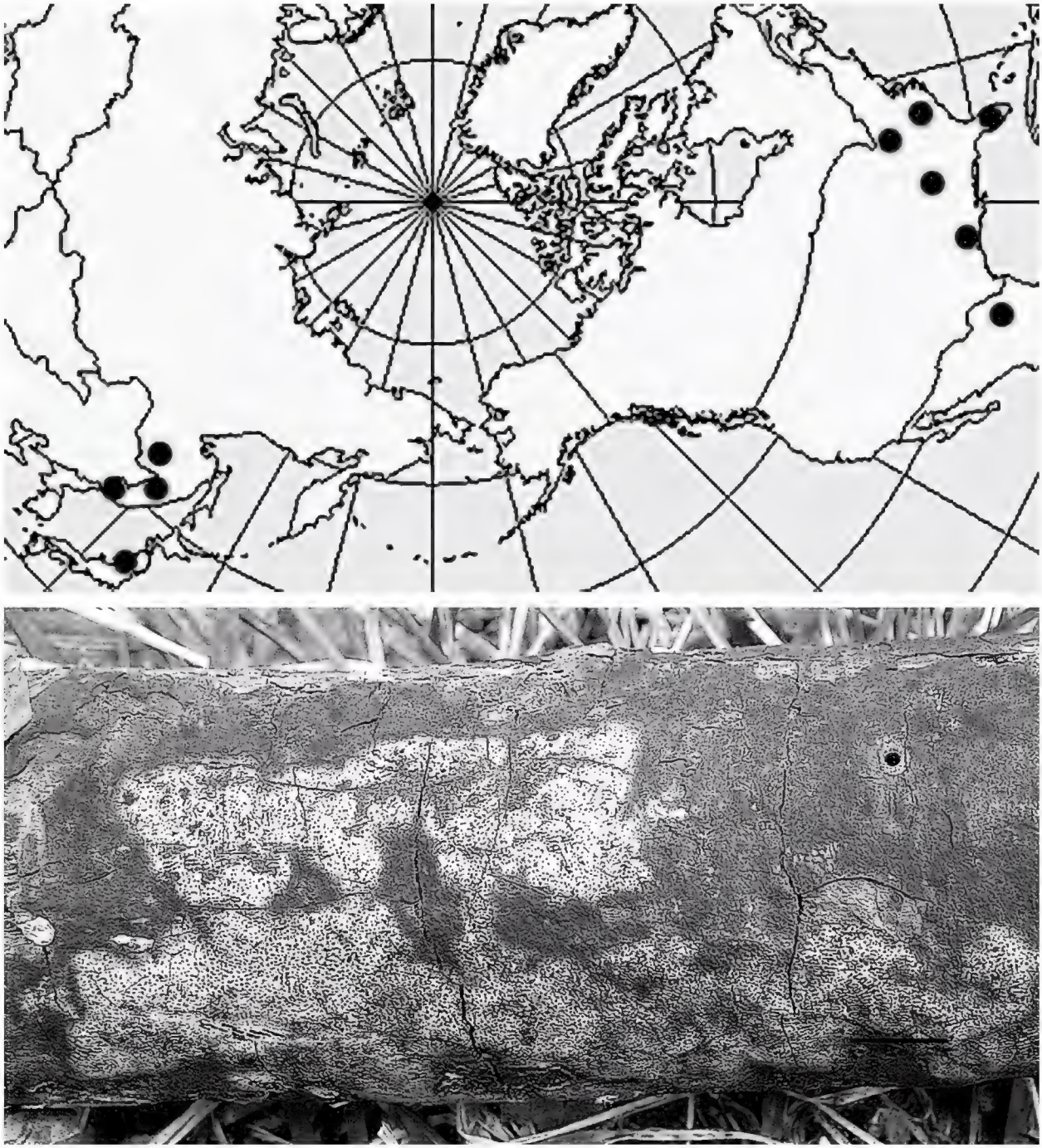

FIG. 12. Approximate biogeographical distributions of *Biscogniauxia maritima* and *B. atropunctata*. North American localities from Mexico (Nuevo León state)] and the USA (Florida, North Carolina, Ohio) are based on Ju et al. (1998) and collections by the senior author in Arkansas (Buffalo National River) and Texas (Big Thicket National Preserve). The species was also found in Tennessee (the Great Smoky Mountains National Park). All eastern Asian collections were obtained by L. Vasilyeva. Scale bar = 0.6 mm

exist within a particular genus or (sometimes) among several closely related genera. An examination of the key to *Biscogniauxia* taxa by Ju et al. (1998) reveals immediately that many taxa differ only in ascospore size (steps 3, 6, 9, 33–34, 36, 40), implying that these taxa are similar in other features. Using these examples (i.e., taxa distinguished at the steps indicated), we arranged the species and varieties on the basis of the average lengths of ascospores (TABLE 1), with each table row presenting a set of closely related taxa.

TABLE 1. Arrangement of some *Biscogniauxia* taxa in accordance with average ascospore length (data from Ju et al. 1998: Key to *Biscogniauxia*). Each table row presents a set of closely related taxa.

ASCOSPORE LENGTH			
10–13 µm	13–17 µm	18–22 µm	22–30 µm
		B. weldenii var. *microspora*	*B. weldenii*
	B. nothofagi		*B. pithodes*
	B. philippinensis var. microspora		*B. philippinensis*
B. uniapiculata	*B. uniapiculata* var. *macrospora*	*B. divergens*	
	B. maritima	*B. atropunctata* var. *intermedia*	*B. atropunctata*
B. citriformis	*B. citriformis* var. *macrospora*		
B. nummularia		*B. bartholomaei*	
	B. mediterranea var. *microspora*	*B. mediterranea*	

Consideration of the information in TABLE 1 shows, for example, that the same difference exists between *Biscogniauxia nothofagi* Whalley et al. and *B. pithodes* (Berk. & Broome) Whalley & Læssøe, *B. philippinensis* (Ricker) Whalley & Læssøe and *B. philippinensis* var. *microspora* Y.M. Ju & J.D. Rogers, and *B. atropunctata* and *B. atropunctata* var. *maritima* (Lar.N. Vassiljeva) Y.M. Ju & J.D. Rogers. Yet the taxa in the first pair are treated as different species, whereas the others are regarded only as varieties. That is taxonomically inconsistent, since the same character difference should not be used at two ranks in the same genus, and if 'varieties' within *Biscogniauxia* display their own biogeographical patterns as do the varieties *atropunctata* and *maritima* of *B. atropunctata* in eastern Asia and eastern North America (FIG. 12), they probably deserve recognition at the species level, as *B. nothofagi* and *B. pithodes* are recognized.

Biscogniauxia mediterranea (De Not.) Kuntze and *B. mediterranea* var. *microspora* display a substrate vicariance, with the autonymous variety occurring only on *Quercus* spp. and var. *microspora* not occurring on *Quercus* but seemingly preferring *Alnus* spp. The latter was found several times on *Alnus* in British Columbia and California (Ju et al. 1998), while are collections from eastern Russia (Khanka Nature Reserve) on *Corylus heterophylla* Fisch. ex Trautv., also in the *Betulaceae*. We regard *B. mediterranea* var. *microspora* as a separate species, for which we propose the name *Biscogniauxia alnophila* below.

Another example of a species with a vicariance pattern is *Hypoxylon ulmophilum* Lar.N. Vassiljeva, common on dead branches of *Ulmus* spp. in the Russian Far East. Vasilyeva (1998) described it as having glomerate stromata

Table 2. Arrangement of some *Hypoxylon* taxa in accordance with average ascospore length (data from Ju & Rogers 1996: Key to *Hypoxylon*). Each table row presents a set of closely related taxa.

Ascospore length			
7–11 µm	11–15 µm	15–22 µm	22–26 µm
H. howeanum	*H. fragiforme*		
H. aeruginosum	*H. aeruginosum* var. *macrosporum*		
H. monticulosum	*H. rubigineoareolatum*		
H. carneum			*H. vogesiacum*
	H. notatum	*H. ulmophilum*	
H. investiens		*H. subcorticeum*	
	H. ferrugineum	*H. diatrypeoides*	
H. annulatum		*H. thouarsianum*	*H. thouarsianum* var. *macrosporum*
H. leptascum		*H. leptascum* var. *macrosporum*	

similar to those found in *Hypoxylon notatum* Berk. & M.A. Curtis but differing in larger ascospores (16.5–21 µm versus 12–15 µm long). Ju et al. (2004) rejected the new species as conspecific with *H. notatum,* but Stadler et al. (2008) later supported it as an independent taxon.

The larger ascospores, a different substrate preference, and the apparent biogeographical pattern suggested a different species. However, once again, the question could be asked as to whether it is possible to rely only upon a single morphological difference, such as the ascospore size. As with ascospore size in *Biscogniauxia*, repetitive average lengths also exist within *Hypoxylon*, where also species (and varieties) appear to differ only in ascospore size. Table 2 compares size differences (steps 7, 12, 31, 33, p. 58–62, etc.) in the key by Ju & Rogers (1996). One can see that the table for *Hypoxylon* contains fewer varieties when compared with the table for *Biscogniauxia*, In other words, average ascospore size (comparable in both Table 1 and Table 2) serves to delimit species in many instances, although using the same difference to delineate both species and varieties is inconsistently applied. If a number of species differ only in ascospore size, then, following simple taxonomic logic, there is justification for recognizing *Hypoxylon notatum* and *H. ulmophilum* as different species.

The concept of *Hypoxylon notatum* in the monograph by Miller (1961) is rather narrow, indicating that it occurs primarily on *Quercus* spp. in the eastern United States (Fig. 13). As such, *H. notatum* represents a counterpart to *H. ulmophilum* in the vicariance pattern under discussion. Later, the concept of *H. notatum* was widened to include some species described from Brazil and Paraguay, as well as specimens from tropical China and Taiwan (Ju & Rogers 1996). In this broader sense, what is currently recognized as *H. notatum* might

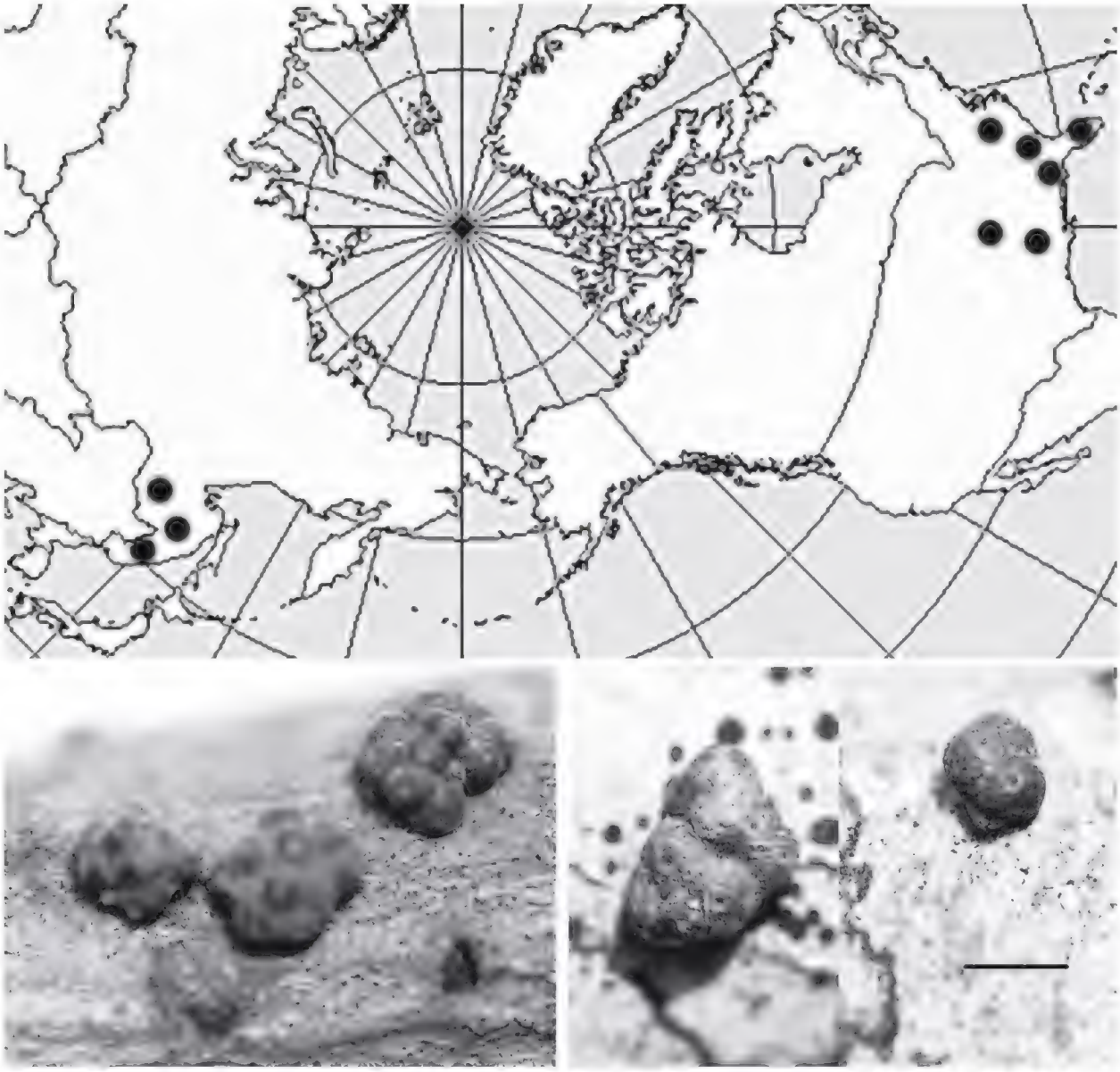

FIG. 13. Approximate biogeographical distribution of *Hypoxylon ulmophilum* (left) and *H. notatum* (right). The North American localities of *H. notatum* are those cited by Miller (1961). The *H. ulmophilum* collections in eastern Asia were obtained by L. Vasilyeva. The latter species was also found in South Korea (Gangwon province, Mt. Odaesan, 20 Sep 2006, VLA P-1651). A. Stromata of *H. ulmophilum*. B. Stromata of *H. notatum*: the widely opening mouth-like ostioles are diagnostic (cf. also Miller 1961, FIG. 7). Scale bar = 1.1 cm

represent a species complex in need of reconsideration. Some support for this view was provided by a specimen from Texas (Big Thicket National Preserve) that is very similar to *Hypoxylon notatum* as illustrated by Miller (1961: FIG. 6–7), but the KOH-extractable stromatal pigments of the Texan specimen are orange in contrast to "pure yellow with greenish yellow tone" reported for *H. notatum* by Ju & Rogers (1996). The latter pigment type was confirmed only for the Taiwanese specimen (Stadler et al. 2008), whereas material from Argentina identified as *H. notatum* had light chestnut pigments (Hladki & Romero 2006). The specimens from the USA studied by Stadler et al. (2008) had a more or less dilute umber pigment in KOH.

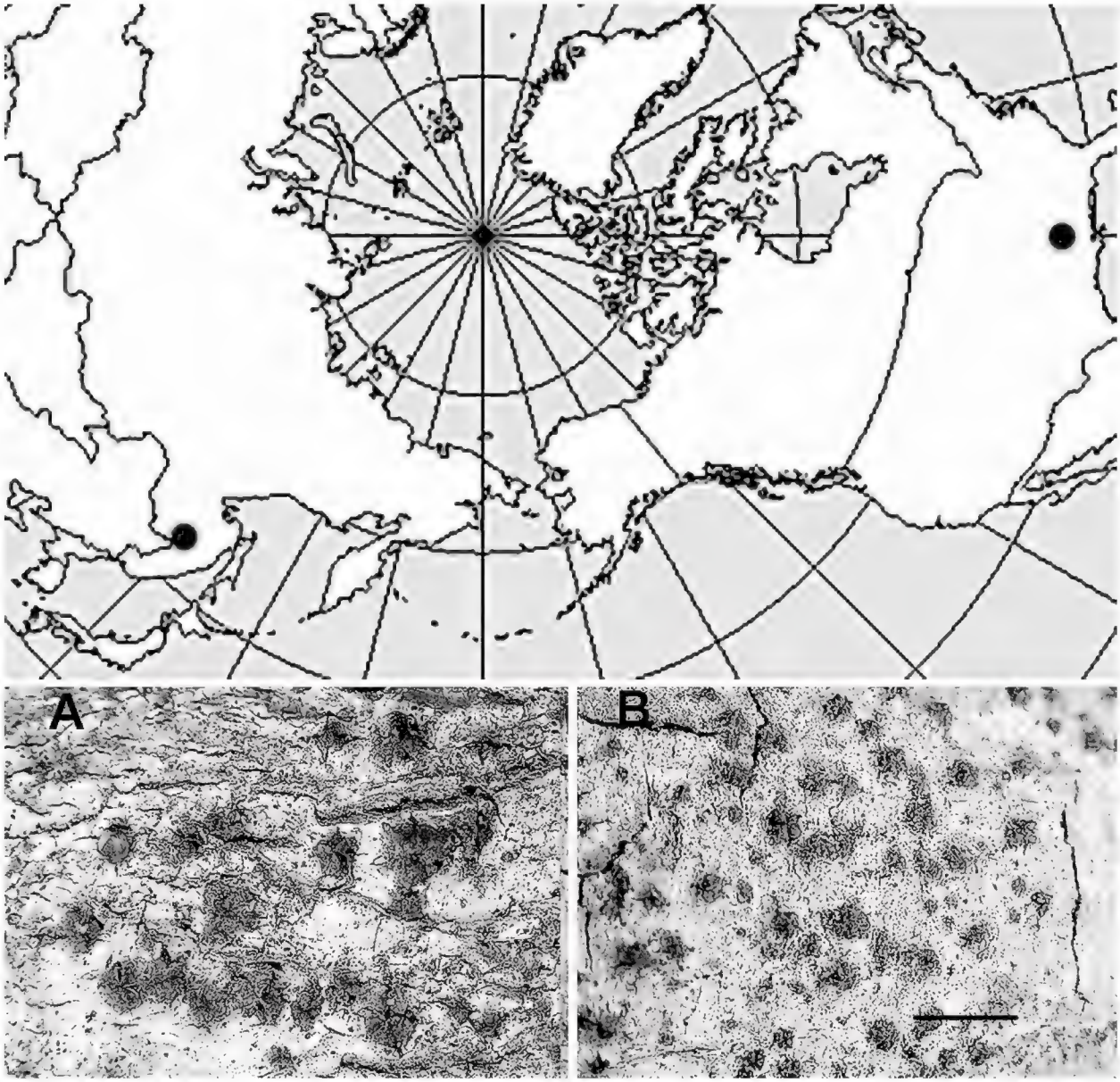

Fig. 14. Known localities for *Cryptovalsaria rossica* and *C. americana* in eastern Russia (the Khabarovsk vicinity) and the USA (Ouachita Mountains, Arkansas). A - Ostioles of *C. rossica* on bark. B - Smaller ostioles of *C. americana* on bark. Scale bar = 2.5 mm

There is no reason to extend this paper by listing additional pairs of pyrenomycetous species that display the vicariance pattern within the Grayan distribution. It is sufficient to mention a very curious case involving closely related species in eastern Asia and southeastern North America parasitizing the same kinds of host trees. These are *Cryptovalsaria rossica* Lar.N. Vassiljeva & S.L. Stephenson and *C. americana* Lar.N. Vassiljeva & S.L. Stephenson, found on living trees of *Alnus* spp. in eastern Russia and Arkansas (Fig. 15) within a time period of six years (Vasilyeva & Stephenson 2007). The situation with these two species is very similar to that with two other ascomycetous species (Whetzel & Wolf 1945), namely *Ciboria shiraiana* (Henn.) Whetzel and *C. carunculoides* (Siegler & Jenkins) Whetzel, parasitizing the fruits of *Morus* spp. in eastern Asia (Japan, South Korea, China, southeastern Russia) and the

southeastern United States (Alabama, Arkansas, Georgia, Florida, Louisiana, Mississippi, North Carolina, South Carolina, Texas).

Taxonomy

Apiognomonia duschekiae Lar.N. Vassiljeva & S.L. Stephenson, **sp. nov.**

MycoBank MB 518664

Perithecia singula, immersa, ut plurimum ad nervi sparsa, sed frequenter ad laminae quoque dispersa, nigra, globosa, 250–300 µm diametro, cum rostri centrali, tenui, recti vel curvati, ad 300–500 µm longi, hypophylli vel epiphylli. Asci numerosi, ellipsoidei, octospori, 50–66 x 9–12 µm. Ascosporae hyalinae, ellipsoideae vel fusoideae, prope basim uniseptatae, ad septum non constrictae, 12–14(–16) × 5–6.6 µm.

Holotypus: Russia, Magadan Region, Susuman vicinity, on dead leaves of *Duschekia fruticosa* (Rupr.) Pouzar (*Betulaceae*), 19.VII.1974, L. Vasilyeva, VLA P-1093.

Perithecia solitary, immersed in leaf tissue, most often along veins, black, spherical, 250–300 µm diam., with central, thin, straight or curved necks up to 300–500 µm long, emerging from the lower or upper leaf surface. Asci numerous, ellipsoid, 8-sporous, 50–66 × 9–12 µm. Ascospores hyaline, ellipsoid or fusiform, septate near basis, not constricted, 12–14(–16) × 5–6.6 µm.

Additional specimens examined: All specimens were collected from dead leaves of *Duschekia fruticosa* by L. Vasilyeva and are deposited in VLA: MAGADAN REGION, Ygodnino District, basin of the river Yasachnaya, 19.VII.1975, P-893; Severo-Evensk District, basin of the river Kegali, 6.VIII.1976, P-894; Bilibino District, basin of the river Ulyashka, 3.VII. 1976, P-892; basin of the river Machvavaam, 13.VII.1977, P-887; basin of the river Bol'shoy Anuy, 25.VII.1980, P-890; basin of the river Ilirney, 13.VIII.1980, P-891; lake Nizhny Ilirney, 21.VIII.1980, P-888; District Ten'kinsky, Kulu vicinity, 12.IX.1975, P-895.

Biscogniauxia alnophila Lar.N. Vassiljeva & S.L. Stephenson, **nom. nov.**

MycoBank MB 518754

≡ *Hypoxylon mediterraneum* var. *microsporum* J.H. Mill., Monogr. of the World Species of *Hypoxylon*: 117 (1961).

≡ *Biscogniauxia mediterranea* var. *microspora* (J.H. Mill.) Y.M. Ju & J.D. Rogers, Mycotaxon 66: 42 (1998).

Description–Miller (1961: 117), Ju et al. (1998: 42).

Specimens examined: RUSSIA, Primorsky Territory: Khanka Nature Reserve, on dead branches of *Corylus heterophylla*, 18 Jun 2003, L. Vasilyeva, VLA P-1858.

Nemania sphaeriostoma (Schwein.) Lar.N. Vassiljeva & S.L. Stephenson, **comb. nov.**

MycoBank MB 518690

≡ *Sphaeria sphaeriostoma* Schwein., Trans. Amer. Philos. Soc., n. ser. 4: 193 (1832).

≡ *Hypoxylon sphaeriostomum* (Schwein.) Sacc., Syll. Fung. 1 : 392 (1882).

Description–Miller (1961: 67; Figs. 100, 128).

Specimens examined: RUSSIA, Primorsky Territory: Lazovsky Nature Reserve, on wood, 2 Aug 1986, L. Vasilyeva, VLA P-380; Ussuriysky Nature Reserve, on wood, 18 Sep 1996, L. Vasilyeva, VLA P-379.

COMMENTS–Superficially, the stromata in the Asian specimens of *Nemania sphaeriostoma* (FIG. 5) and in Miller's photograph (1961: FIG. 100) are similar to both *Euepixylon udum* (Pers.) Læssøe & Spooner and *Nemania confluens* (Tode) Læssøe & Spooner (Granmo et al. 1999: Figs. 17, 42), and the distribution of the two latter species among different genera was made on the basis of *Euepixylon udum* having ascospores with elliptic, poroid germ slit, whereas *Nemania confluens* is characterized by ascospores with a narrow, long germ slit. However, this difference is hardly of generic importance, since the size of germ slit (which in some instances is seemingly lacking) varies within many genera of the *Xylariaceae*, within which this difference is usually used to distinguish species in such genera as *Hypoxylon* (Ju & Rogers 1996), *Biscogniauxia* (Ju et al. 1998) and *Nemania* (Ju & Rogers 2002).

When reinstated, the genus *Euepixylon* was distinguished from *Nemania* on the basis of "a short poroid germ locus, a very short ascus stipe, and a broad, discoid apical apparatus" (Læssøe & Spooner 1993: 41), but the authors themselves expressed doubts that this genus would survive in the long run. Later, the name *Euepixylon* was said to be invalid (Eriksson & Hawksworth 1997), so the genus *Nemania* is more suitable for *Hypoxylon sphaeriostomum* on the basis of both the logics of taxonomic comparison as well as nomenclatural rules.

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